

motion the chief star should have been found along the line marked 1892-1837.

Thus at the time of the Cordoba observation the distance, instead of being $29''$ as observed, would have been about $50''$, in the time of h about $90''$, the angles as well being altered.

If we assume the mass of the close pair equal to that of the Sun, its parallax will be $0''.12$; and if we now see the third star under an angle equal to its semi-axis major, its period of revolution would not be greatly different from 4,000 years.

The magnitudes of the three stars are 6.1 , 8.1 , and 10 ; but it is well to state that for the latter, estimates vary from 7 to 12—viz.

Gould	...	9.5
Russell	...	7.0
Burnham...	...	10 to 12.

Royal Observatory, Cape of Good Hope:
1897 December 3.

The Wilsonian Theory and Mr. Howlett's Drawings of Sun-spots.
By the Rev. Aloysius L. Cortie, S.J.

In Dr. Wilson's paper entitled "Observations on the Solar Spots" (*Phil. Trans. R.S.* vol. lxiv. A.D. 1774), in which his theory with regard to the cavernous nature of Sun-spots relatively to the photospheric level is propounded, he particularly calls attention to the fact that the phenomenon of the unequal foreshortening of the penumbra on either side of the umbra (or umbra and nucleus in his phraseology) is only to be observed in those spots which are not subject to any disturbance, the appearances to be expected under normal conditions being sometimes counteracted when changes have occurred in the spots during their transit across the solar disc. The Wilsonian hypothesis has lately been called in question by the Rev. Mr. Howlett, whose contention is that the Sun-spots are in general elevations above rather than depressions below the photospheric level. The admirable series of enlarged drawings of the solar spots made by this indefatigable observer have been most generously presented to the Society, and are preserved in our library. From an examination of many of these drawings it would seem that the rule that has guided Mr. Howlett in the selection of his cases against the Wilsonian hypothesis is that any spot in the neighbourhood of the limb which shows the penumbra of greater extent on the side towards the centre of the Sun is a case against the cavernous theory of the spots. In the remarks in the index which precedes each volume such expressions sometimes occur as "seemed to favour Wilson, but umbra not central and the group

actively changing." But if spots that seemingly tell for the Wilsonian theory are to be rejected and put out of court for these reasons, surely the same reasons are equally cogent in cases which tell against the theory. In fact, as Father Sidgreaves has well pointed out in his paper on this subject (*Monthly Notices R.A.S.* vol. iv. No. 5, 1895 March), no spot ought to be admitted as a suitable test in the present controversy in which the following conditions are not verified : "(1) That the spot had been observed at a position approximately between $30''$ and $60''$ of arc from either limb ; (2) that it had been watched on its passage between the central meridian and the limb ; (3) that it was a compact regular spot ; (4) that it showed a central umbra when remote from the limb ; and (5) that it was a quiet spot, not indicating a tendency to divide or change shape."

As the careful examination of so large a number of spots as Mr. Howlett has drawn would have taken a considerable amount of time, a volume was selected at haphazard, and the spots which are chronicled as against Wilson for the year 1883 were studied in detail. They are thus indexed :—

No.	Spot.	Date (1883).
313	η	Apr. 20
314	σ	May 11
316	ψ	June 3
317	u	June 4
320	ξ	July 18
321	β	June 30
329	ω	Sept. 4
330	ι and ζ	Sept. 8
335	δ and ϵ	Oct. 17

Eleven cases, therefore, are furnished for examination, and of these the spots 313 η and 316 ψ have no life histories recorded in Mr. Howlett's drawings, and hence it is impossible to say whether they should be admitted as test cases. A reference to the Stonyhurst drawings of these groups is against their admission, on account of their disturbed nature. The spot 314 σ , too, showed great changes between May 17 and 18, as can be seen from the sheet 315, and must be excluded from the discussion. Spot 317 u must also be rejected on account of the disturbances registered on June 3 and 4. The spot 320 ξ in the enlarged drawing made at 7.30 A.M. on July 18 is seen to be of a broken outline with bright patches in the penumbra ; and on the 21st, when nearly central, shows penumbra on one side only, and that the inner side from the Sun's centre. The next spot, 321 β , underwent a period of disturbance between June 25 and 29. With regard to 329 ω it is depicted as a black line nearly on the limb, but so hazy and ill-defined that it is impossible to determine whether it be composed of umbra or penumbra. There is no

enlarged drawing of the spot on the previous day, but on August 26 an enormous extent of faculae is recorded on the preceding limb. From the drawings, too, it would appear that this spot is identical with the spot ϵ of August 23 and 26; and if so, between these two dates the umbra had separated into three parts, with a great change in the penumbra. The spots 330 ι and ζ must likewise be rejected as being disturbed spots, and moreover in the case of the first the umbra was not centrally placed with regard to the penumbra. As to the disturbed nature of the spots, the evidence furnished by the drawings with regard to the first is that on September 8, at 4.30 P.M., it had two nuclei which had coalesced into one by 8 A.M. the next morning; while with regard to the latter its nucleus on September 3 was long and compact; on September 4 it showed evident signs of breaking up; and when on the limb on September 8 the S. part of the spot was composed of penumbra which corresponded to the penumbral tail of September 3 and 4. Of the group 335 δ and ϵ the latter spot was of irregular outline, with scattered umbra and penumbra on October 13, and two days after a portion on the preceding side was detached from it. Again on October 17 there was much faculae near the limb, and, as Secchi has pointed out, the presence of faculae in the region of a spot frequently counteracts the appearance it would present were it a cavity; and moreover in this case the spot, if admitted at all, would seem to tell rather for than against the depression hypothesis. There remains the group 335 δ , which on October 13 consisted of four spots, two of them—and these the more northerly—being irregular and disturbed, and two being of more constant outline. Of these two again one had not the umbra central on October 13, but the penumbra was much more extensive on the inner side than on the outer side, and hence when foreshortened apparently told against Wilson's view. There remains but one spot to be dealt with, and that is the most southerly of the whole group. On October 13 the umbra extended rather in the E. and W. direction, the penumbra being more extensive on the N. than on the S. of the spot. On October 15 the umbra is represented as lying more in the N. and S. direction, as if the spot had partly turned on its axis. On October 17 the penumbra is about equal on each side of the umbra, instead of being less on the inner side, and so far is against Wilson.

From this discussion of the individual cases quoted it would appear that the witness of all these spots, with one possible exception, must be rejected. The study of these cases was made from Mr. Howlett's drawings, without any reference to, or help from, other drawings or photographs, so as to avoid all bias and prejudice. Subsequently, however, all the above spots were studied on the Stonyhurst drawings, with the exception of 329 ω , and of part of the group 330 ι and ζ , of which we have no record. In every case the description of the spots given above is fully

corroborated, and the only spot which can possibly tell against the Wilsonian hypothesis is the most southerly member of the group 335, which on October 17 was about $25''$ of arc from the preceding limb of the Sun. The evidence of this one spot is reliable, but by no means weighty, as adverse to the depression hypothesis.

Among the cases of Sun-spots indexed by Mr. Howlett (vol. vii.) as "decidedly adverse to Wilson" are two dated 1887 July 4 and July 6. The evidence of the Stonyhurst drawings with reference to these examples can be studied in Plate 7 of the *Memoirs R.A.S.* vol. xlix. p. 286, illustrating Father Perry's paper on "Photographs and Drawings of the Sun." Group 4 of the plate corresponds to Mr. Howlett's first case, and it will be seen on reference to the series of reproductions of the drawings, which are somewhat smaller in size than the originals, that on July 3-4, when the spot is near the following solar limb, the evidence is apparently against Wilson, but on the 14th, when near the preceding limb, it is much more strongly, seemingly, in his favour. But it will be noticed that the evidence is weakened by the drawing on the 13th, and from the shifting of and changes in the umbra from day to day as the spot crossed the limb. If the spot is to be regarded as a test case, then as far as the Stonyhurst drawings bear witness it cannot be said to be "decidedly against Wilson," but rather in his favour. This case was rejected as unreliable in the discussion of the bearing of the Stonyhurst series of drawings on the Wilsonian hypothesis. With regard to the spot dated 1887 July 6, group 3 of the plate shows a spot which is in favour of the depression theory when on the preceding limb, and this cannot be the spot referred to. But in group 5 we can study two normal spots as they cross the disc, and of these the first is against Wilson's theory on the 6th, but again for the theory when on the preceding limb on the 17th; while the second one, though a small spot, is against Wilson both on the 6th and 17th. The reproduction of the 18th is not quite correct; the original is against Wilson. Hence it appears that the Stonyhurst drawings bear out Mr. Howlett's contention in one of his two "decided" cases, and that only partially. But there is one set of drawings—those, namely, which constitute group 2 of the same plate—which is a very strong case against the Wilsonian view. Father Sidgreaves has already called attention to this example, in his paper before referred to, as indicating rather a mountainous than a cavernous form of umbra in the spot.

It would appear, then, from this detailed examination of some of the cases adduced by Mr. Howlett that their evidence is by no means conclusive against the Wilsonian theory. On the other hand it must be admitted that the phenomena presented by many spots are directly contrary to the theory, and from a careful study of these on the Stonyhurst drawings Father Sidgreaves has been led (*loc. cit.*, p. 286) to a partial confirmation of Mr. Howlett's adverse criticism. To the writer it seems, without contesting in

Jan. 1898.

and Mr. Howlett's drawings.

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any way or expressing any opinion upon the theory advocated in opposition to the depression hypothesis of Sun-spots, that the strength of the position taken up by Mr. Howlett is not warranted by his drawings, and that the weight of the negative evidence derived from them must be modified.

Stonyhurst College Observatory :
1898 January 14.

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Observations of Occultations of Stars by the Moon and of Phenomena of Jupiter's Satellites made at the Royal Observatory, Greenwich, in the year 1897.

(Communicated by the Astronomer Royal.)

Day	Phenomenon.	Telescope.	Power.	Moon's Limb.	Mean Solar Time of Observation.	Observer.
Apr. 15	Disapp. W.B. XII. 334	Astrographic Equat.	225	Dark	11 32 38.24	J.
	Reapp. Piazzi IV. 287	Altazimuth	100	Bright	8 38 0.98	H.
May 4	Disapp. W.B. (2) IV. 1358-9	"	100	Dark	8 39 49.58	"
4	" W.B. (2) VI. 1452	"	100	"	9 36 31.67	A. C.
6	" W.B. (2) VI. 1447	Sheepshanks Equat.	100	"	9 38 30.78	J.
6	" Piazzi XXI. 291	"	100	Bright	13 42 37.24	S.
June 18	Reapp.	"	100	Dark	14 10 47.50	"
18	" Lalande 31226	Astrographic Equat.	225	Bright	9 6 41.95	W.
July 11 (a)	Disapp. χ^1 Sagittarii	Sheepshanks Equat.	55	Dark	9 21 4.17	B.
13	"	Altazimuth	100	"	9 21 4.27	S.
13	"	Astrographic Equat.	225	"	9 21 3.87	W. S.
13 (b)	Reapp.	Sheepshanks Equat.	225	Bright	10 22 (10.20)	B.
13	"	Altazimuth	100	"	10 22 7.82	S.
23	Disapp. 17 Tauri	Astrographic Equat.	225	"	12 17 2.78	C. D.
23	"	Sheepshanks Equat.	100	"	12 17 (0.09)	W. S.
23	" 16 Tauri	Astrographic Equat.	120	"	12 40 35.43	C. D.
23	Reapp.	"	120	Dark	12 53 29.52	"